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CONNECTICUT
AGRICULTURAL EXPERIMENT STATION.

NEW HAVEN, CONN.

BULLETIN 122, MAY, 1896.

COST OF NITROGEN, PHOSPHORIC ACID AND
POTASH IN CONNECTICUT. SPRING
MONTHS OF 1896.

VALUATIONS.

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BULLETINS.

The Bulletins of this Station are mailed free to citizens of Connecticut and to others who apply for them, until the editions are exhausted.

Applications should be renewed annually before January 1st.

The matter of all the Bulletins of this Station, in so far as it is new and of permanent value, is made a part of the Annual Reports.

~~☞~~ All Bulletins earlier than No. 71 and also Nos. 83, 93, 100 and 118, are exhausted and cannot be supplied.

STATION REPORTS.

The Annual Reports of this Station, printed at State expense, are by law limited to editions of 12,000 copies, of which 5,000 copies are bound with the Annual Reports of the Connecticut State Board of Agriculture, and distributed by the Secretary of the Board, T. S. Gold.

After exchanging with other Experiment Stations and Agricultural Journals, the reports remaining at the disposal of the Station will be sent to citizens of Connecticut who shall seasonably apply for them, and to others as long as the supply lasts.

~~☞~~ The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1883, 1887, 1891, and 1893, but some of them may be obtained from Secretary T. S. Gold, of West Cornwall, Conn., at the cost of postage.

RETAIL CASH COST OF NITROGEN, PHOSPHORIC
ACID AND POTASH IN CONNECTICUT.*

Spring Months of 1896.

NITROGEN.

NITRATE OF SODA.

The per cent. of nitrogen in the eleven samples recently analyzed ranged from 15.53 to 16.21 and averaged 15.92. The ton price of nitrate ranged from \$40 to \$48.

The cost per pound of nitrogen ranged from 12.7 to 15.0 and averaged 14.2 cents.

Several farmers who bought "mixed car lots" of fertilizers, for cash, got nitrogen in form of nitrate at prices ranging from 11.8 to 13.8 cents per pound *delivered*, and averaged 12.6 cents.

SULPHATE OF AMMONIA.

But two samples of this material have been examined.

They contained 20.84 and 20.92 per cent. of nitrogen, cost \$70.00 and \$65.00 respectively, so that nitrogen cost 15.5 cents and 16.8 cents per pound in the two samples.

COTTON SEED MEAL.

Forty-seven analyses of this material have been made, of which forty-two represented yellow hulled meal.

The cash retail cost per ton ranged from \$20.50 to \$24.00 per ton. The per cent. of nitrogen ranged from 6.28 to 8.12 and averaged 6.97 per cent.

Phosphoric acid and potash were not separately determined in these samples, because the percentages of these two ingredients, in yellow hulled meal, vary but little from the average, which is 2.81 per cent. of phosphoric acid and 1.85 per cent. of potash.

Allowing $4\frac{1}{2}$ cents and 5 cents per pound respectively for the phosphoric acid and potash, the cost per pound of nitrogen in

* All the analyses of fertilizers referred to in this Bulletin have been made by Messrs. Winton, Ogden and Mitchell, chemists of this Station.

prime meal has averaged 12.7 cents, ranging from 11.2 to 15.5 cents.*

Four samples of dark unhulled meal, analyzed for farmers, contained on the average 4.03 per cent. of nitrogen, 2.06 of phosphoric acid and 1.59 of potash. At \$17.00 per ton nitrogen cost 16.8 cents per pound, at \$15.00, it cost 14.3 cents:—in any case very considerably more than in prime yellow meal.

For use as a fertilizer it will not pay the farmer to use dark unhulled meal at any price at which it is now offered.

One sample analyzed was said to be from a lot which was being shown to farmers in East Hartford and vicinity as representing goods for future delivery and offered at a little less than the regular price for prime yellow meal.

The hulls in it were very fine ground so that it had the general appearance of hulled meal a little off color.

Timely warning was given by the Station in the agricultural papers and we cannot find that any such meal was finally delivered.

LINSEED MEAL.

There is now offered for use as a fertilizer screened linseed meal which is very fine and dry.

Six samples recently examined contained nitrogen ranging from 6.28 to 6.93 and averaging 6.54, with 1.79 per cent. of phosphoric acid and 1.22 per cent. of potash.

The average cost per ton has been \$20.00 and the average cost per pound of nitrogen 12.9 cents, ranging from 12.3 to 13.7 cents.

CASTOR POMACE.

Three samples of this material have been analyzed this year.

The cost ranged from \$18.00 to \$20.50 per ton, the per cent. of

* To make clear the method of calculation this example will suffice. A given sample of meal contains 7.12 per cent. (or pounds per hundred) of nitrogen, 2.81 of phosphoric acid and 1.85 of potash. In one ton therefore are 20 times these amounts, or 142.4 pounds of nitrogen, 56.2 of phosphoric acid and 37 pounds of potash.

56.2 pounds of phosphoric acid at 4½ cents per pound cost \$2.53 and 37 pounds of potash at 5 cents cost \$1.85, or \$4.38 for the two ingredients. The meal costs \$22.75 per ton. Subtracting \$4.38, leaves \$18.37 which is reckoned as the cost of the other ingredient,—nitrogen,—of which there are 142.4 pounds. Dividing the cost, \$18.37, by the number of pounds, 142.4, gives the cost of one pound of nitrogen which is 12.9 cents.

nitrogen from 4.74 to 4.92 and the cost of nitrogen per pound from 15.5 to 18.2 cents, averaging 17 cents per pound.

Nitrogen costs more in Castor Pomace than in any other organic form.

DRY FISH.

Four samples of Fish have been examined.

Two of them contained nitrates, added probably to bring the per cent. of nitrogen up to the guarantee.

These four samples contained from 7.56 to 9.42 per cent. of nitrogen with from 6.58 to 7.22 per cent. of phosphoric acid.

Oil of vitriol is often added to the fish to hinder putrefaction during drying, and this treatment partly dissolves the bones of the fish, forming superphosphate.

Allowing $5\frac{1}{2}$, 5, and 2 cents per pound respectively for soluble, reverted and insoluble phosphoric acid, the actual cost of nitrogen per pound in fish has averaged 14.5 cents, ranging from 11.4 to 16.6 cents. The price of fish per ton ranged from \$26.00 to \$32.00.

PHOSPHORIC ACID.

DISSOLVED BONE BLACK.

The average composition of four samples analyzed has been, soluble phosphoric acid 15.4, reverted 1.95, insoluble .28, and the average cost of "available," that is soluble and reverted phosphoric acid together, has been 6.6 cents per pound, ranging from 5.9 to 7.4 cents.

ACID PHOSPHATE.

This name is applied to the material got by treating any mineral phosphate (Charleston phosphate, etc.) with oil of vitriol.

The three samples examined had an average composition of 12.3 per cent. soluble phosphoric acid, 2.1 reverted and .85 per cent. insoluble.

The "available" phosphoric acid has cost on the average 4.8 cents per pound.

In "mixed car lots," delivered, purchasers have bought the available phosphoric acid of dissolved bone black for from 6.2 to 6.8 cents per pound, of acid phosphate for from 3.6 to 3.8 cents.

POTASH.

MURIATE OF POTASH.

The per cent. of potash in twelve samples ranged from 47.50 to 54.13, averaging 50.61.

Cash retail prices ranged from \$42.50 to \$45.00 and the average cost per pound of actual potash was 4.16 cents.

Purchasers of mixed car lots of chemicals delivered, paid from 4.04 to 4.17 cents per pound for actual potash, averaging 4.1 cents.

HIGH GRADE SULPHATE OF POTASH.

This material is quite constant in composition and on the average (5 analyses) contained 49.2 per cent. of actual potash. The potash has cost at retail in this form 4.9 to 5.2 cents per pound.

Purchasers of mixed car lots have bought it, delivered, at 4.8 and 4.9 cents per pound.

DOUBLE SULPHATE OF POTASH AND MAGNESIA.

The average per cent. of potash in the six samples analyzed was 26.5—ranging from 25.30 to 28.01—and the average cost per pound of actual potash was 5.6 cents.

A single purchase in a “mixed car lot” is reported at a price which made the cost of actual potash 4.04 cents, delivered.

COTTON HULL ASHES.

Twenty-nine analyses, recently made, showed the usual wide differences of composition, potash *soluble in water*, ranging from 15.40 to 30.64, and phosphoric acid from 5.96 to 11.68.

The *average* per cents. of these two ingredients have been respectively 23.1 and 9.7.

Allowing 5½, 5 and 2 cents per pound for the water-soluble, citrate-soluble and insoluble phosphoric acid respectively, potash soluble in water has cost from 3.8 cents to 10.9 cents per pound and on the average 6.6 cents.

This potash is in the form of carbonates and phosphates and is particularly prized by the tobacco growers, though it is equally well suited for other crops.

GROUND TOBACCO STEMS.

This is a finely ground powder having the composition shown in the following analyses of two samples.

| | Sample A. | Sample B. |
|-----------------------|--------------|--------------|
| Nitrogen----- | 2.58 | 3.13 |
| Phosphoric acid ----- | .70 | .86 |
| Potash ----- | 7.06 | 9.63 |

If we value nitrogen at 13 cents per pound and phosphoric acid at 5 cents, the actual cost of potash in these two samples is 5.7 and 8.8 cents respectively. The samples contained only traces of chlorine. The stems cost \$20.00 per ton.

WOOD ASHES.

These are usually regarded as a potash fertilizer but should rather be regarded as a source of lime, in form of carbonate—for which they are chiefly valuable, supplying it in finely divided form and cheaply, considering its fineness.

The seventeen samples received this season have contained from 2.04 to 6.66 per cent. of potash soluble in water and from 1.32 to 2.10 per cent. of phosphoric acid. Excluding two samples which were evidently partially leached, the ashes have contained on the average:

| | |
|-------------------------------|-------|
| Potash soluble in water ----- | 5.07 |
| Phosphoric acid ----- | 1.56 |
| Lime----- | 25.90 |
| Sand and Soil ----- | 14.50 |
| Charcoal ----- | 2.00 |

Allowing 5 cents a pound each for phosphoric acid and potash, the cost of lime, (\$11.00 per ton for ashes), is little more than $\frac{2}{3}$ of a cent per pound, which is cheaper than lime can be bought in the same form elsewhere.

SUMMARY.

In conclusion, to summarize the preceding facts, there is shown in the following table the average retail cash prices of nitrogen, phosphoric acid and potash in the raw materials and chemicals named above.

CASH RETAIL COST PER POUND OF NITROGEN, PHOSPHORIC ACID AND POTASH IN CONNECTICUT.

(SPRING MONTHS, 1896.)

| NITROGEN. | Cents Per Pound. | |
|-------------------------------------|------------------|--------------|
| | Average cost | Ranging from |
| Nitrate of Soda | 14.2 | 12.7 to 15.0 |
| Sulphate of Ammonia | 16.2 | 15.5 " 16.8 |
| Prime hulled Cotton Seed Meal | 12.7 | 11.2 " 15.5 |
| Unhulled Cotton Seed Meal | 15.5 | 14.3 " 16.8 |
| Linseed Meal | 12.9 | 12.3 " 13.7 |
| Castor Pomace | 17.0 | 15.5 " 18.2 |
| Dry Fish | 14.5 | 11.4 " 16.6 |

AVAILABLE PHOSPHORIC ACID.

| | | |
|----------------------------|------------|------------|
| Dissolved Bone Black | 6.6 | 5.9 to 7.4 |
| Acid Phosphate | 4.8 | 4.2 " 6.6 |

POTASH SOLUBLE IN WATER.

| | | |
|----------------------------|-------------|------------|
| Muriate of Potash | 4.16 | 3.9 to 4.3 |
| High Grade Sulphate | 5.10 | 4.9 " 5.2 |
| Low Grade Sulphate | 5.60 | 4.9 " 6.3 |
| Cotton Hull Ashes | 6.6 | 3.8 " 10.9 |
| Ground Tobacco Stems | 7.3 | 5.7 " 8.8 |

Bone and tankage are not included in the foregoing discussion because both contain nitrogen and phosphoric acid in hard granules, not easily soluble in water, and their value as fertilizers depends largely on the size of these granules.

Therefore to determine the cost of nitrogen or phosphoric acid in them would involve an estimation of the value of each ingredient in bone granules of different sizes.

This would lead us too far from the special object of this Bulletin.

THE PROPER USE OF TABLES OF ANALYSES OF
FERTILIZERS AND FERTILIZER CHEMICALS.

By E. H. JENKINS.

On page 162 of the Report for 1895 is a paper by the Director of this Station, on The Best Economy of Concentrated Fertilizers.

The paper is designed to illustrate the facts that "the interests of those who buy as well as of those who sell commercial fertilizers can be best promoted by a knowledge, well applied, of all the factors of crop-production; that the plant, like the man, to flourish, not only requires an abundant and varied bill of fare, but also a suitable lodging and the comforts of a well-appointed home; that the best economy of commercial fertilizers is to be attained by intelligently investigating what special wants of the soil or crop their various grades are adapted to meet, and what further wants of soil or crop must be attended to in order to prevent that impoverishment of land and landholder which otherwise, sooner or later, is likely to ensue—the experience of which has led many agriculturalists to the erroneous conclusion that concentrated fertilizers are 'stimulants and not nourishment,' and that they 'exhaust the soil,' whereas they merely aid the farmer to exhaust the soil by rapidly removing, in the crops, substances which the soil unaided can supply but slowly or insufficiently and by impairing or destroying one or several of those conditions which are indispensable to plant-production."

This knowledge the farmer can get, partly from books, but partly only by careful and constant observation and experiment on his own land.

He must know, for instance, whether the water supply and drainage and texture of his soil are such that fertilizers can come to effect on his crops; whether his soil is specially deficient in some one ingredient, as lime or potash; and what elements of plant food his several crops take off from his soil, and how much of them he can put back in crop residues and in stable manure.

Only when he knows these things can he make rational use of the analyses of commercial fertilizers and fertilizer chemicals, which are yearly published by this Station.

For it is clear that if his soil is cold and sour because of deficient drainage, or is parched with drought in summer, money spent in any kind of fertilizers is likely to be thrown away.

If his land is specially deficient in nitrogen or in potash, his

first effort must be to supply these things by heavy dressings of nitrogenous manures or potash fertilizers, and until this is done, it will be of little use to apply phosphoric acid.

The question regarding commercial fertilizers to be settled with the help of this knowledge of his land and cropping is:

For the given crop, how many pounds per acre of nitrogen, of phosphoric acid and of potash is it wise for me to apply?

It is in order to supply these three ingredients that he uses commercial fertilizers. If these are not lacking in the soil, it is idle to use commercial fertilizers at all.

We will suppose that he has decided to use per acre 65 pounds of nitrogen,—20 of it in form of nitrate,—50 of phosphoric acid and 90 of potash.

He is now ready to avail himself of the facts which it is the business of this Station to supply, and which will be found, in part, in the pages of this Bulletin.

In studying the tables of analyses given in Station Bulletins and Reports, his first question will not be—which brand of factory-mixed goods shows the highest Station valuation or the least difference between cost and valuation, but rather how can I get this 65 pounds of nitrogen, 50 of phosphoric acid and 90 of potash in the most available forms and at the cheapest price? To find this out he does not need to depend on Station "Valuations" for help.

He can *himself* make valuations more accurate *for his special use*, than the Station can make.

There are two reasons for this. The Station Valuations are a general approximation, not for any particular place, but for freight centers throughout the State. The farmer's valuation will be quite accurate for his particular town or village.

Again, the Station Valuations are based on average quotations for six months or a year. The farmer's valuation will be true for the week in which he makes his purchase.

The Station's office is to show him what different articles contain, what their agricultural value under test conditions is, to protect him from frauds in fertilizers and to give him what general information it can on the subject of fertilization.

It is his duty, not the Station's, to see what his fertilizers will cost him and in what particular way he can buy cheapest.

Now the purchaser can buy this 65 pounds of nitrogen, 50 of phosphoric acid and 90 of potash in one of two ways; either mixed, finely ground and ready to apply at once in commercial

“Phosphates,” “Superphosphates” and “Special Manures,” or he can buy them separately in form of agricultural chemicals, etc., then pulverize, if necessary, and mix them, or apply them to the land separately.

In any case, the next thing is to find out the actual cost to him of nitrogen, phosphoric acid and potash, when bought for cash, each by itself.

This the Station does in order to fix a schedule of valuations and a similar thing any business man would do before purchasing stock of any kind.

The system of valuations is correct in principle, and there is not a fertilizer manufacturer in the country who is not forced to resort to it in buying his raw materials.

The system is continually misrepresented as being an attempt to indicate what the fair price of a fertilizer is. It is nothing of the sort; but shows what the amounts of nitrogen, phosphoric acid and potash contained in a fertilizer would cost *on the average*, for cash, at freight centers in raw materials unmixed.

This information has been of great value as a general guide to buyers.

After twenty years' experience under this system it is, however, believed that the progressive farmers of this State are perfectly capable of making valuations to suit their own particular cases, which will be more accurate for their own conditions of market than any which the Station can make.

In what follows it is shown how a valuation or schedule of valuations may be made, accurate for the time and place where made and how it may be used by the practical farmer.

NITROGEN.

It has been shown in the first part of this Bulletin that the materials in which organic nitrogen is the leading ingredient and which are in the Connecticut retail market now are dry fish, cotton seed meal, linseed meal and castor pomace.

(Dried blood is not generally offered at retail, the “tankage” in market—known as “bone tankage” in the trade—is more a phosphatic than a nitrogenous fertilizer.)

No better forms of organic nitrogen than the vegetable matters named above are to be found.

The experiments made at this Station during the last two years, as well as the experiments of Wagner in Germany previously made, indicate that the nitrogen of dried blood, of cotton seed,

linseed and castor pomace is about equally available; and more available than that of fish, bone, or tankage.

Therefore the choice must be determined chiefly by the cost of nitrogen with due regard also to mechanical condition.

Linseed—specially screened for fertilizer use—and cotton seed are of about equal fineness; the linseed drills rather easier because free from lint. Castor Pomace is somewhat coarser.

Referring to the tables on page 8 it appears that the cost of nitrogen per pound in these various articles has been this spring as follows:—

| | Average. | Extremes. |
|---------------------------|----------|-----------|
| In Cotton Seed Meal | 12.7 | 11.2-15.5 |
| Linseed Meal | 12.9 | 12.3-13.7 |
| Castor Pomace | 17.0 | 15.5-18.2 |
| Dry Fish | 14.5 | 11.4-16.6 |

It is evident that organic nitrogen costs (Spring of 1896) about 13 cents per pound, and that it may cost as low as 11.2 or as high as 18.2 cents, depending on the purchaser's distance from large markets, his care in buying and the use he makes of the Station in testing the quality of the material offered him.

That is, he *may* save 7 cents per pound or for his 65 pounds of nitrogen \$4.55 by care in buying the one item of nitrogen.

He may reckon on getting the following quantities of nitrogen, phosphoric acid and potash in every 100 pounds of cotton seed meal, linseed meal, or castor pomace that he buys.

| | Nitrogen. | Phosphoric Acid. | Potash. |
|---------------------------|-----------|------------------|---------|
| In Cotton Seed Meal | 6.9 | 2.8 | 1.8 |
| Linseed Meal | 6.6 | 1.8 | 1.2 |
| Castor Pomace | 4.8 | 3.0 | 1.0 |

But if buying considerable quantities it will in any case be wise for the purchaser to send samples for analysis to the Station and in *all* cases to buy with a distinct guarantee.

We will assume that he finds he can buy cotton seed meal at \$22.00 per ton containing 6.9 per cent. of nitrogen, 2.81 per cent. of phosphoric acid and 1.85 per cent. of potash, in which therefore nitrogen costs him 12.8 cents per pound; and that he chooses this form of organic nitrogen.

The nitrogen of nitrates can only be bought economically in nitrate of soda, at a cost of from 12.7 to 15.0 cents per pound, as appears from the figures given on page 8.

We will also assume that he can buy nitrate of soda, containing 16 per cent. of nitrogen, for \$45.00 per ton.

PHOSPHORIC ACID.

The two available forms in which this is found in market, practically free from other fertilizer ingredients, are "acid phosphate,"—rock phosphate dissolved by oil of vitriol—and dissolved bone black.

There is no reason to believe that the soluble or "reverted" phosphoric acid in one of these is any more easily available to plants than in the other.

The acid phosphate is the form used by most manufacturers of fertilizers, on account of its greater cheapness. It has a tendency, however, to cake or set, especially when mixed with nitrate or potash salts, unless some dry material, like cotton seed or linseed meals, bone dust, or the like is added. Dissolved bone black, however, never sets in this way.

Available (water-soluble and citrate soluble) phosphoric acid can be bought in the latter form for 6.6 cents per pound.

In acid phosphate it costs considerably less, but for some reason acid phosphate is not commonly sold by retail dealers in Connecticut.

It is, however, extensively used by farmers in other States with excellent results and can be readily bought in the New York and New Jersey market at low prices.

In car lots it has been laid down at freight centers for \$10.60 per ton or less, this spring, and if there were demand for it, could probably be retailed for \$15 or less per ton, thus making the cost of available phosphoric acid about $4\frac{1}{2}$ to 5c. per pound.

We assume for the purposes of our illustration that the purchaser finds he can buy acid phosphate for \$16.00 per ton containing 14 per cent. of available phosphoric acid.

POTASH.

Leaving out of account ashes, the chief sources of potash for agricultural use are the imported potash salts, muriate, high grade sulphate and double sulphate. As the table shows,

| | Averages. | Extremes. |
|--|-----------|-----------|
| Potash in Muriate costs, cents per pound.... | 4.16 | 3.9-4.3 |
| " " high grade Sulphate..... | 5.10 | 4.9-5.2 |
| " " low " " | 5.60 | 4.9-6.3 |

Returning now to the assumed case in which the farmer wishes to get 20 lbs. nitrate nitrogen, 45 lbs. organic nitrogen, 50 lbs. available phosphoric acid, 90 lbs. potash:—

From the data given in this bulletin and the quotations given by dealers, he can calculate very accurately what they will cost laid down at his freight station, as follows:—

We assume that he can buy nitrate of soda for \$45 per ton, or \$2.25 per 100 lbs.; cotton seed meal for \$22.00, or \$1.10 per 100 lbs.; acid phosphate for \$16.00, or 80 cents per 100 lbs.; and muriate of potash for \$42.50 per ton, or \$2.13 per 100 lbs.

To get 20 lbs. of nitrate nitrogen he needs 125 lbs. of nitrate of soda, costing \$2.82.

Forty-five lbs. organic nitrogen require 652 lbs. cotton seed meal, costing \$7.17. This quantity of meal also carries about 2.8 per cent. or 18 lbs. of phosphoric acid and 1.8 per cent. or 11 lbs. of potash.

To get the remaining 32 lbs. of phosphoric acid will require, say 230 lbs. of acid phosphate, costing \$1.84, and the remaining 79 lbs. of potash will require 158 lbs. of muriate, costing \$3.36.

| | | |
|-------------------------------------|-------|---------|
| 125 pounds Nitrate of Soda, costing | ----- | \$2.82 |
| 652 " Cotton Seed Meal " | ----- | 7.17 |
| 230 " Acid Phosphate " | ----- | 1.84 |
| 158 " Muriate of Potash " | ----- | 3.37 |
| 1165 " costing----- | ----- | \$15.20 |

This represents a cost *per ton* of unmixed chemicals of \$26.10, with the following composition :

| | |
|--------------------------------|----------------|
| Nitrogen as Nitrates----- | 1.71 per cent. |
| " Organic ----- | 4.00 " |
| Phosphoric Acid available----- | 4.30 " |
| Potash as Muriate----- | 7.72 " |

The figures which represent the actual costs of nitrogen, phosphoric acid and potash in these unmixed chemicals are the "Schedule of trade values," which the careful purchaser will apply to the ready-mixed goods that are offered to him, viz. :

| | |
|---------------------------------|-----------|
| Nitrogen as Nitrates----- | 14 cents. |
| " Organic ----- | 12.8 " |
| Available Phosphoric Acid ----- | 5.8 " |
| Potash as Muriate----- | 4.2 " |

To illustrate: one of the high grade factory-mixed fertilizers recently analyzed contains :

| | |
|--------------------------------|----------------|
| Nitrogen as Nitrates----- | 2.91 per cent. |
| " Organic ----- | 2.17 " |
| Available Phosphoric Acid----- | 7.6 " |
| Potash as Muriate----- | 6.8 " |

and costs \$38 per ton.

This contains somewhat less nitrogen and potash and a good deal more phosphoric acid than the particular formula of chemicals above given; and on the whole contains per ton more cash value of fertilizer ingredients by about \$1.75. Deducting this from \$38.00, the cash price, we have \$36.25.

This \$36.25 is then the price at which the farmer could buy approximately the same amount of chemicals as his formula contains, finely ground, thoroughly mixed, bagged and ready to put on his land.

The difference between this and the cost, \$26.10, of the chemicals unground and unmixed, namely, \$10.15, is the price he must pay for having the work of grinding and mixing done for him.

This brings him to the last question of all—which is the cheapest, to do it myself or have it done for me?

If he is using only small quantities of fertilizer, half a ton or less, or if he does not attend to it till the pressure of spring work is upon him, unquestionably the latter course is cheapest; if the chemicals are, as is often the case, fine and dry, or can be bought milled fine, for only a slight advance, and the amount used is large, it will often pay well to do the mixing at home. No general rule can be given, each farmer must figure and experiment for himself, undisturbed by the dictum of those who have had no experience in the work.

In what has been said we have taken for illustration quickly available but also the cheapest forms of nitrogen, phosphoric acid and potash which are on the market.

These are not always the most economical to use.

For instance, the use of muriate of potash on tobacco is fatal to the crop, and the quality of potatoes may be injured by it, so that the higher priced sulphate is used instead.

Again, some soils which are deficient in lime, as well as potash, are more economically dressed with both, in form of wood ashes, than by separate applications of stone or oyster shell lime and a potash salt.

It is very likely that cotton hull ashes, by reason of the alkali in them, pay better to use on some soils than either the muriate or sulphate of potash, although the actual potash in them costs considerably more.

Where land is laid down to grass, fine bone is preferred by many to the more soluble and quickly available forms of nitrogen and phosphoric acid.

There is often great advantage, too, in changing the form of

fertilizer from time to time, rather than in dressing the land year after year in the same way. Such a change prevents an undue accumulation in the soil of any one ingredient not assimilated by the crop in considerable quantity. For instance, the use of superphosphate year after year, for a long time, may cause an accumulation of sulphates which, by reducing the amount of carbonate of lime within the soil, or in other ways, may be injurious.

All these points demand the careful attention of the farmer and are matters which each individual must attend to for himself.

To recapitulate :—

1. Before buying fertilizers in any quantity, the farmer should decide—from what he can find out about his land and the past and prospective cropping,—how many pounds of nitrogen, phosphoric acid and potash he will use per acre, and whether any particular forms of these ingredients are specially desirable.

This decision, involving, as it does, some thought and study, though it may not accurately meet the needs of land and crop, will make clear to him the uses and the limitations of fertilizers.

It is what no one can do for him, and it is certainly a great advance over the plan of putting on half a ton or a ton of "fertilizer" or "superphosphate" per acre, regardless of anything but the cost per ton. This last plan, followed by many, is like prescribing half a pint of "medicine" per day for a patient, without naming either dose or drug.

2. The farmer should then get from a number of sources quotations of such fertilizer chemicals as will serve his purpose with definite guarantees of composition and clear understanding as to rebates in case the goods are not as guaranteed, and in the ways indicated in the preceding pages, calculate what he must pay for the quantities of nitrogen, phosphoric acid and potash that he has decided upon, delivered at his freight station.

3. The purchaser should then find out what he must pay in cash for an amount of factory-mixed fertilizer that contains approximately the quantities of fertilizer ingredients which he has determined to apply per acre. This cost of the factory-mixed goods will almost always be considerably larger than the cost of unmixed chemicals.

4. This difference in cost between the two is to be offset against the cost to him of possible pulverizing, mixing and bagging the chemicals, and he has lastly to determine which will probably be the cheaper method, all things considered.

This he cannot determine until he has followed the course just indicated.



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